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North Atlantic TRAWL NETS

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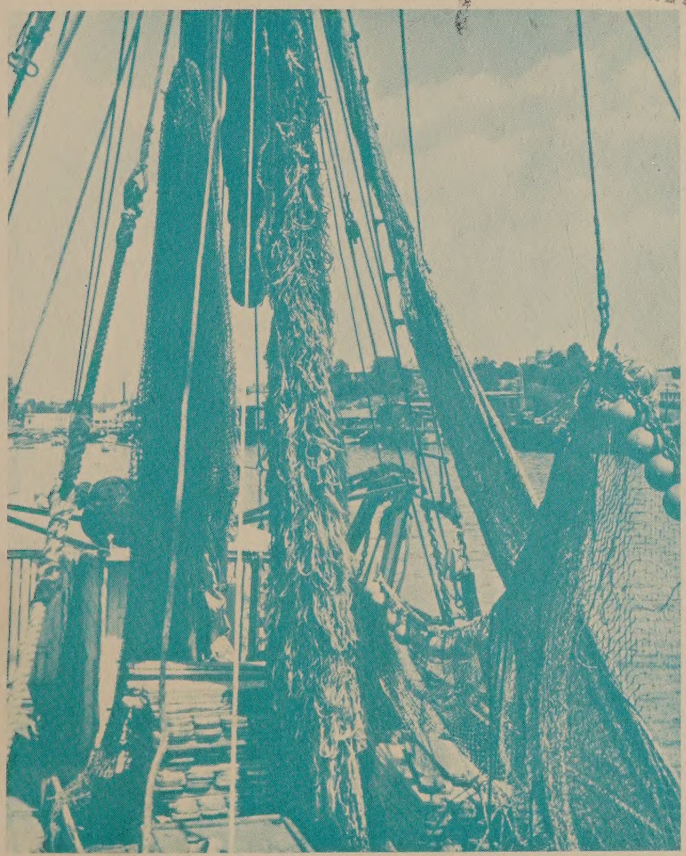

UNITED STATES DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
BUREAU OF COMMERCIAL FISHERIES

Fishery Leaflet 600

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North Atlantic Trawl Nets

By

ROBERT A. BRUCE

Fishery Leaflet 600

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By

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ABSTRACT

This leaflet is designed to answer requests for information about otter trawls currently used in the North Atlantic fisheries. Its major emphasis is on trawls used on New England trawlers, but it also includes some of the trawls used by other countries fishing the fishing grounds of the northwest Atlantic.

Data such as overall size, twines, mesh sizes, rope and wire size, roller and chain gear, flotation, rigging, and certain construction details accompany the drawings and texts for each net described. The designs cover trawls for vessels from 55 feet with 220-hp. (horsepower) engines to 250 feet with 2,400-hp. engines.

INTRODUCTION

Recent developments in the design of trawl nets in countries with relatively large fishing fleets suggest that the fishing efficiency of the otter trawl can be improved. Papers describing various tests on new and traditional trawl nets have established certain facts about these nets and have elaborated on the problems with both relatively standard designs and with altered or new nets. Continuing experiments with new and improved instruments have provided more information on nets and suggest the possibility of further improvement in trawl design. Sometimes test results are contradictory or inconclusive, but total knowledge on net characteristics is increasing, and the belief persists that trawls can be made more efficient if the net and its gear are modified.

One of the results of these varied activities has been the experimental trial and actual use of trawls of a design other than the "typical" otter trawl. These different nets are called "new" by many because they differ in some respects from what is commonly being used; however, many of these so-called innovations are not new. For example, when examining two of the more frequently discussed types of nets--the wing trawl and the box or 4-seam trawl--we find that wing trawls have been successfully used in Scandinavian fisheries for over 50 years and that a box trawl was patented in England over 40 years ago.

Increased trawl and gear research, comparative fishing tests between the "standard" and "new" nets, and economic expediency have led an increasing number of foreign fishing vessel operators to try different trawl nets. New England trawl fishermen have recently turned to increased experimentation with standard trawls, "new" trawls, and new materials. Efforts to change New England otter trawls include altering the wings, changing the headrope and footrope length ratios, experimenting with reducing lower wing damage, and changing the lengths of legs and ground cables. Because of these diverse changes it is difficult to describe a typical "name" net, and to do so is to invite the reader to compare the net with which he is familiar to the "name" net illustrated here--the differences may be considerable.

This leaflet illustrates some of the typical nets that New England, European, and Canadian fishermen use in groundfishing. Rigging details on the 2-seam trawls are restricted to the wing and mouth areas for most of the nets illustrated because of the similarity in rigging such parts as the bellies and cod ends of all 2-seam trawl nets. Greater attention to the differences in rigging is given the 4-seam or box trawl and the Polish factory stern trawl.

EXPLANATION OF TWINE CUTTING TERMINOLOGY

This brief description of cutting tapers uses the terminology most common in the United States and Europe. This cutting method is based on the parts of a mesh or meshes

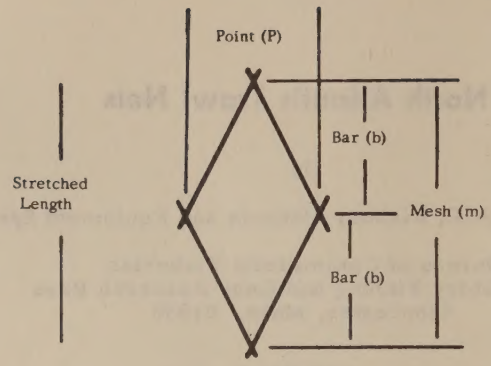


Figure 1A - Parts of a mesh

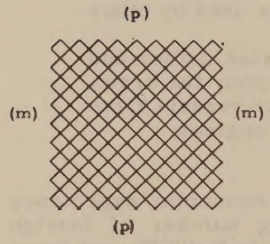


Figure 1B - Webbing cut along meshes and points.

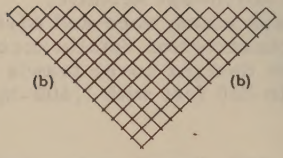


Figure 1C - Webbing cut along bars.

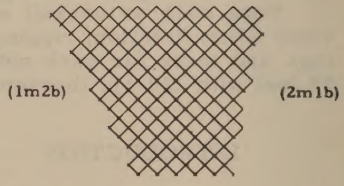


Figure 1D - Webbing cut in common tapers.

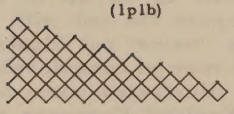


Figure 1E - Webbing cut along points and bars

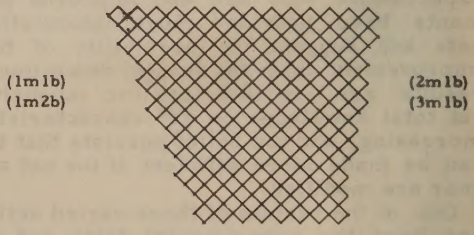


Figure 1F - Webbing cut using combination of cuts.

Figure 1A.--Nomenclature of a mesh. 1B.--Webbing cut along meshes (m) and points (p). 1C.--Webbing cut down along bars (b) both sides. 1D, 1E, and 1F.--Illustrations of typical tapers.

that remain along the tapered edge after the unwanted webbing is cut away.

Figure 1A shows a mesh with its parts named and those parts that may remain along the tapered edge of a net section.

Meshes (m) and bars (b) make up most of the parts in most tapers of trawl net sections. Either meshes or bars, or a variety of combinations of meshes and bars, will be used. In this leaflet, if meshes and bars are used in the taper, the mesh is given first. On North Atlantic trawl nets, points (p) are found almost exclusively in the wedge sections if these sections are used.

Figure 1B shows a piece of webbing having both vertical sides cut along meshes--this cut is known as a "straight cut down." The illustration also shows both horizontal edges cut along points--this cut is known as a "straight cut across." The resultant webbing

section, which is cut along meshes down and points across, is rectangular; there is no taper in this section. It is always assumed that when netting is cut, the webbing hangs in a stretched mesh condition.

Figure 1C shows a piece of webbing cut along bars (b) on either side and points (p) across the top. This cut, along bars only, results in a diagonal cut through the section of webbing. The common dog-ear or fly-mesh edges of many wing sections are made from this cut along bars.

Figures 1D, 1E, and 1F show various combinations of cuttings that result in typical tapers. Note that figure 1F shows combinations of more than one sequence of meshes and bars. This combination removes the unwanted webbing and provides the desired taper when one sequence of meshes and bars is unable to give the intended taper. Standard netmaking practice allows a difference of one mesh from the net's plan specifications.

The tapers included in this leaflet came, whenever possible, from the sources supplying the diagrams and descriptions of the enclosed nets. When this taper information was not supplied, I used a standard method of determining tapers.

GRANTON TRAWL

The Granton trawl (fig. 2) is the standard net that has been used for the past quarter century aboard large deep-sea trawlers in England. This net and the Aberdeen trawl are the most common trawl nets now used by British trawlers and are similar to most of the deep-sea, bottom-fishing, 2-seam nets used in continental Europe.

The designers of the Granton trawl have a long tradition of bottom trawl experience dating back to the beam trawl. These designers made changes to the older trawls so that the new nets could meet the requirements of larger vessels, which had more power, fished on new and rough fishing areas, and had new equipment such as otter doors, danlenos, and the Vigneron-Dahl (V-D) door hookup gear. To obtain good fishing characteristics the upper and lower wings were varied in width and length, the length and mesh sizes of the bellies were changed, and the section tapers and hanging ratios were altered. All these changes led to an effective groundfish net. An accepted feature of this net is that the lower wing, measured along the selvedge, is 10 percent longer than the combined upper wing and square. This difference allows the webbing to lift and provide greater headrope height. Two sizes of the Granton trawl popular in the British distant-water fisheries emerged from these efforts--one with a 116-foot footrope (fig. 2) and a larger trawl with a 136-foot footrope.

The need for easy assembly of the net ashore and the need for replacement sections to expedite repairing the net at sea encouraged manufacturers to standardize the nets. The current trend away from hand-

Table 1.--Construction details for the Granton trawl

Part	Specifications
Headrope	One piece of 4" cir. (circumference) manila or synthetic rope, 78' (feet) long, marked 29' - 6" (29 feet, 6 inches) from each end. Allow for eye on each end.
Fishing line	Seven lengths of 7/8" dia. (diameter) comb. (combination) wire rope: 14' - 6"; 14' - 6"; 20'; 20'; 20'; 14' - 6"; 14' - 6". Total length 118', without allowing for connecting links. A 120' footrope can be used.
Footrope	1" dia. 6 x 19 wire. Same measurements as fishing line.
Wing end rope	Two lengths 7/8' dia. comb. wire rope, 4' long.
Hanging lines	1/2" dia. rope. Top and lower wings.
Floats	Fifty 8" dia. aluminum floats. 20 on bosom, 15 on each wing.
Roller gear	20' footrope units for bosom and quarters. Bosom: Five 24" dia. or seven 21" dia. iron bobbins, spacers as needed. Quarters: Five 21" dia. or seven 18" dia. iron bobbins, spacers as needed. Wings: 4" to 6" dia. rubber disks along 14' - 6" lengths of footrope. Roller chains placed at 4' intervals.
Footrope for seabed fishing (flatfish)	Seven lengths of 1" to 1-1/4" dia. wire rope. The same measurements as the fishing line. Round all wires with 2-1/2" cir. manila rope.
Bellyline legs	One piece 5/8" dia. 6 x 19 wire, 13' - 6" long, eye each end. Runs from footrope quarter shackle along a bar to selvedge.
Selvedge lines	3" cir. rope, seized along selvedge from bellyline legs to end of cod end.

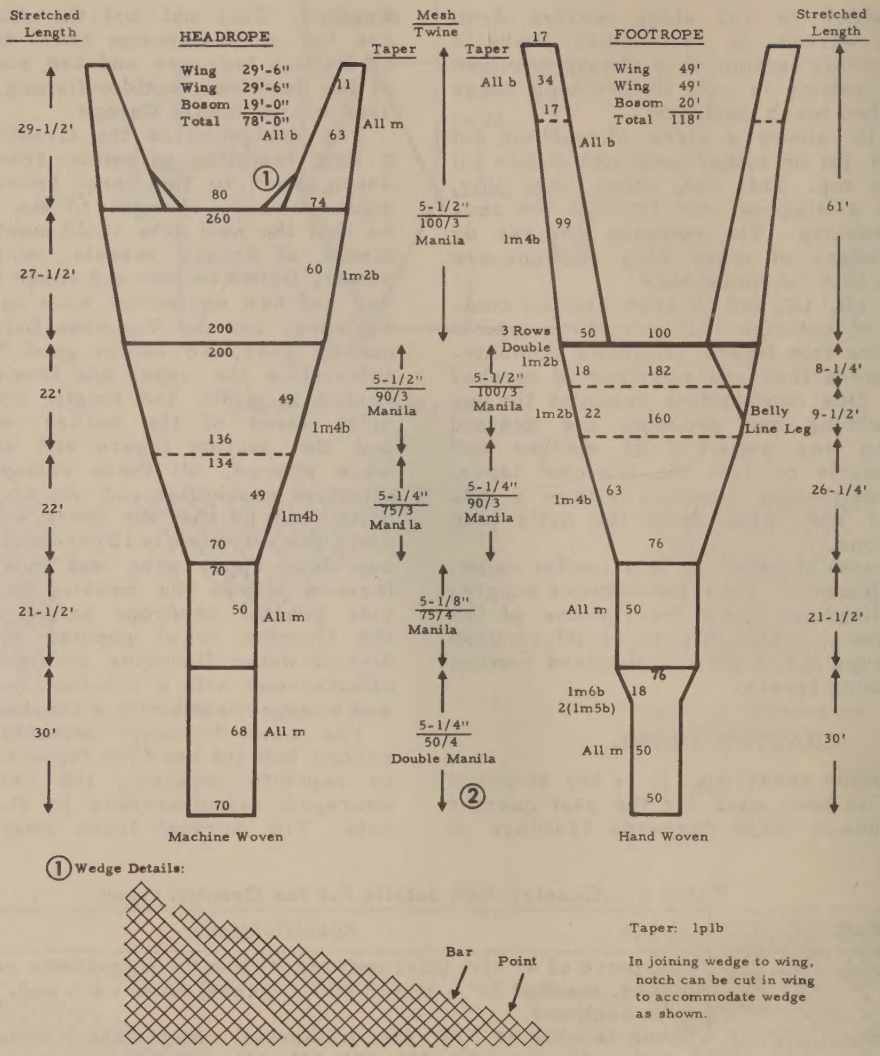


Figure 2.--Granton trawl.

made sections and toward the use of machine-made webbing stimulated development of a more simplified design with a two-part belly and straight cod end (fig. 2, left illustration).

A wedge section, identical with or similar to that used on the top wings, is often included on the lower wings. With machine-made webbing, this wedge is a simple addition to the net. The wedge is used because fishermen believe that it strengthens the "strain" areas and helps maintain the proper "set" of the net while it is being towed.

The ever-widening search for groundfish by British vessels requires that the Granton trawl be fished over rougher seabeds than in the past. To reduce gear damage and loss to an acceptable level, both the net and its rigging have been changed. An example of these changes (the Polish factory ship's trawl) is illustrated in figure 7.

Although primarily roller-rigged for groundfishing, the Granton trawl is occasionally used on smooth bottom when fishermen wish to tow the net close to the seabed. The roller gear is removed and a heavy wire-rope footrope is hung to the net.

Construction details for the Granton trawl given here apply to trawls made of both machine-woven and handwoven netting. Some of the terms used are those common to the English fishermen. The differences that would exist between the machine-woven and handwoven nets are primarily in the bellylines, bellyline legs, splitting straps, haul-up ropes, and strongbacks (if used). The sizes and measurements for these units are not included except for the bellyline leg--it is the only item that may be unfamiliar to American commercial groundfishermen. Notice the longer belly and the tapered cod end in the handwoven net (fig. 2). These are not meant to coincide with the machine-woven net but specifically to provide an example of changes allowable in the Granton trawl.

NUMBER 41 TRAWL

The basic trawl net used by the large draggers and "beam trawlers" from New England ports is the Number 41 trawl (fig. 3). This European-designed trawl replaced the Icelandic trawl in New England about 20 years ago because of the difficulty of acquiring Icelandic nets and spare parts. Sections for the Number 41 trawl used in this country have generally been imported from Europe. It produces satisfactory yields compared to its larger predecessor.

Few changes have been made to the basic Number 41 trawl in recent years. The belly has been simplified by reducing the number of mesh sizes from three to one (to accommodate mesh regulations), and the lengths of the wings have changed slightly. The headrope and footrope lengths have remained at 79 feet and 100 feet, respectively.

Number 41 nets, until recently, have been made of manila hemp twine. Use of new fibers--nylon, polypropylene, and polyethylene--in net twines has progressed to the point where most of the Number 41 trawls in use today are composed of synthetics. Notable exceptions to this trend are the continued use of manila bottom bellies and lower wings aboard vessels fishing on hard bottom where nets are subject to repeated damage. The Number 41 illustrated is a twisted-nylon net except for the cod end, which is of No. 102 braided-nylon. An extension (if used) could be made of No. 200 polypropylene. Fig. 3 shows a Number 41 trawl with a belly 77 meshes deep; 90-mesh bellies are available for large trawlers.

The major difference between the Granton trawl and the Number 41 trawl used by many

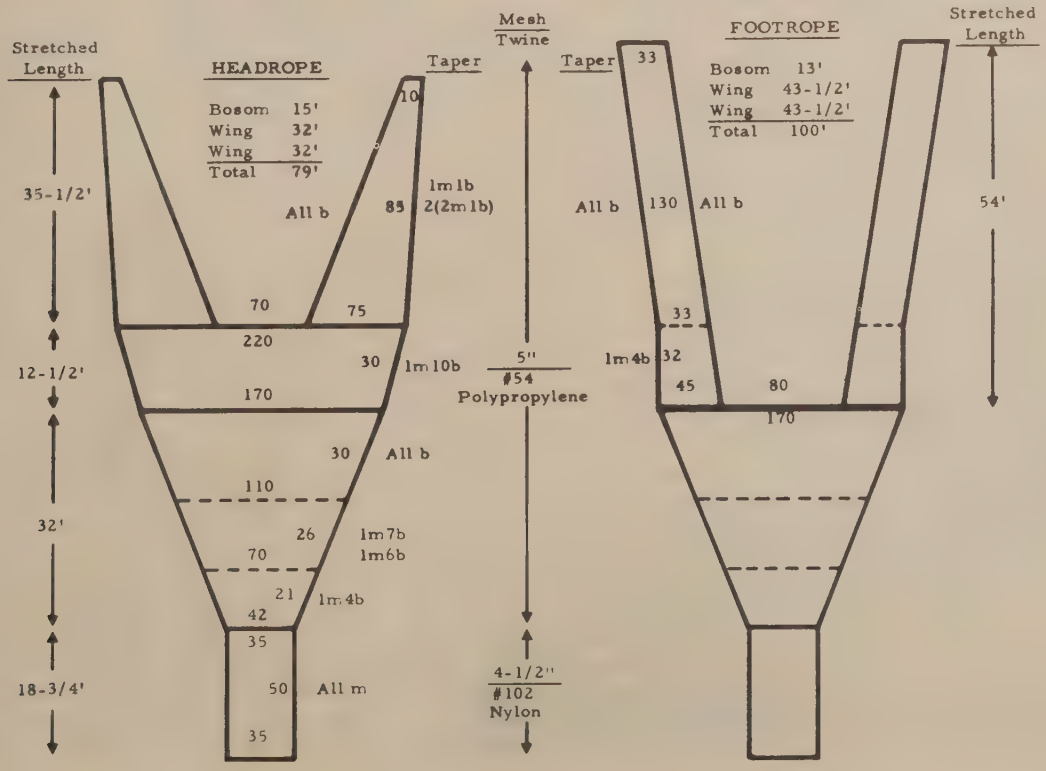


Figure 3.--Number 41 trawl.

of the larger New England trawlers is the greater overhang of the Granton's square. This extra length allows a greater width of the mouth opening; the square is 30 meshes wider at the belly and 40 meshes wider at the bosom. The Granton is also 24 meshes longer from the wing end to the forward end of the extension.

Table 2.--Construction details for the Number 41 trawl

Part	Specifications
Headrope	Three lengths, 7/8" dia. comb. wire rope, each 26'-2" long joined by links = 79' long. Marked 32' from each end.
Footrope	Five lengths, 3/4" or 7/8" dia. 6 x 19 wire rope 100' long: 18 1/2' + 25' + 13' + 25' + 18 1/2'. (Allow for connecting links.)
Hanging line	One piece 3 1/4" or 4" cir. synthetic rope, 105' long marked 45 1/2' from each end. Hung 45 1/2' from each end. Hung 45 1/2' on wings, 14' on bosom. (The hanging line arrangement described replaces the traditional light hanging line and wire fishing line used with roller gear. The roller chains secure directly to this heavy hanging line.)
Wing end ropes	Two lengths 7/8" dia. comb. wire rope, 6' & 11' long.
Floats	Fifty to sixty 8" dia. aluminum floats, 10 to 12 on each wing, remainder on bosom. (Some nets have 1 to 2 extra floats on each wing end.)
Roller arrangement	Bosom rollers - 6 or 7 wooden or rubber rollers 16" to 18" dia. Spacers as needed. Wing rollers - Ten 16" dia. rollers, three spacers between. Remainder of 25' long wire covered with rubber discs. Wings - 18 1/2' footropes covered with 3 1/2" dia. rubber discs. (Some nets alter wing roller arrangement using a 30' length for wing rollers. Remaining wing footrope is changed to a 13 1/2' length and covered with 3 1/2" dia. rubber disks.)

SKAGEN OR TYPE "S" WING TRAWL

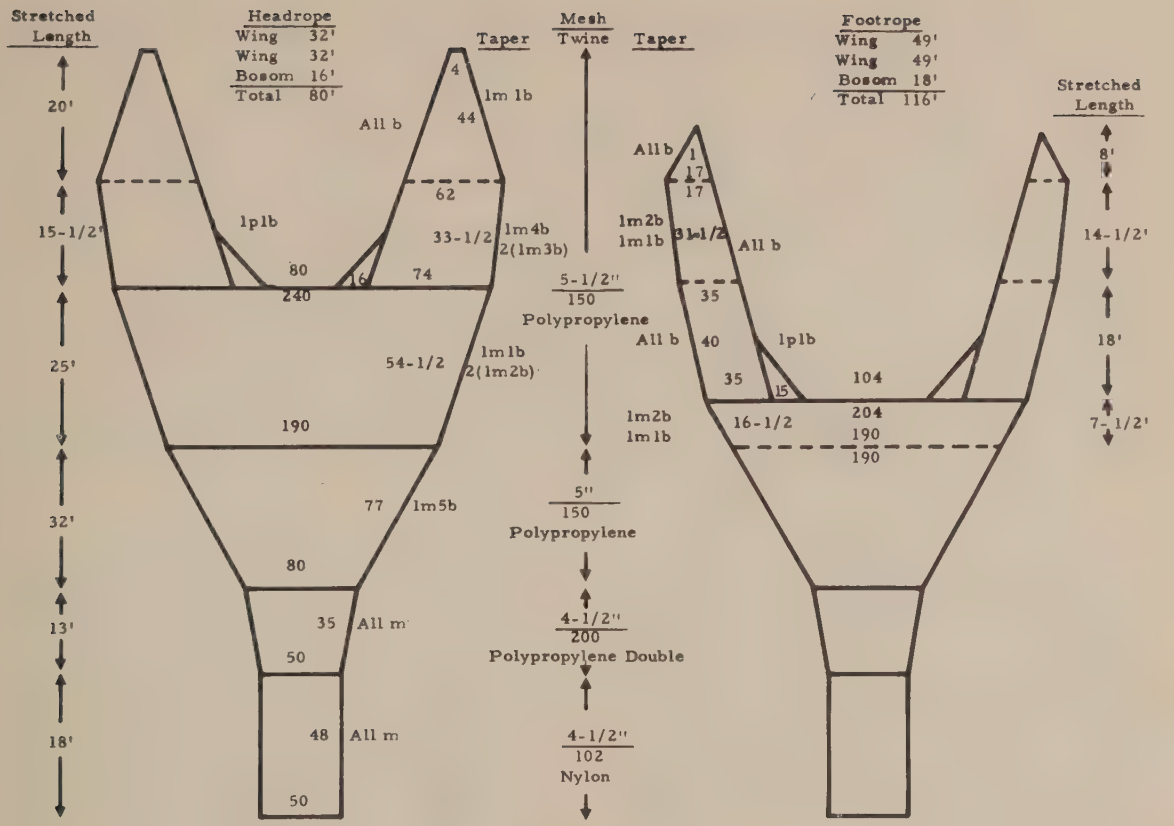
The Skagen or type "S" wing trawl (fig. 4) is a 2-seam net that has attracted interest in recent years because of its growing acceptance in Europe and Canada. This trawl is adapted from a Scandinavian net used both as a trawl with doors and as a Danish seine net for pelagic and bottomfish. Redesign of the lower wings and use of heavier twine adapted this net for rough bottom fishing. The result was a higher opening net that had the qualities desired by many fishermen.

The important differences of the wing trawl as compared to the large New England trawl nets are: (1) dovetail wing ends, (2) deeper square, (3) wider belly, and (4) wider top wings. These factors result in a net with a greater overhang, a larger mouth area, and a greater headrope height.

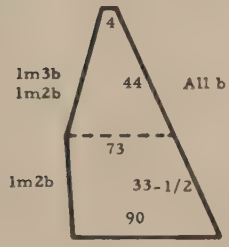
The original wing trawl also had a much longer belly of various size twines and a longer extension section; these measurements were reduced, and the variety of mesh sizes eliminated on the bottom-fishing wing trawls. These changes reduced the high rate of damage experienced with the longer nets and the time lost patching multimesh-size bellies. First efforts at fishing this net on hard bottom resulted in catches that were encouraging. To reduce damage in the normally full lower wings, the wings were redesigned to eliminate a large portion of the webbing. Continuing alterations to this net have resulted in a shortening of the lower wing--it was once of equal length to the top wing and square--and the elimination of more webbing.

Information about this net was provided by a Canadian net and gear supplier who sells this net and its sections to a number of Canadian vessels. Comparative fishing data between the Number 41 and Granton trawls and the wing trawl indicate that the wing trawl is effective enough to merit its continued use. Fishing results with a wing trawl used by a Boston fishing vessel also suggest that this net does have fish-catching ability comparable to the Number 41 trawl used by most vessels in that fleet.

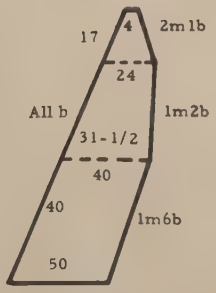
The rigging of the Skagen or type "S" wing trawl is similar in most respects to the standard 2-seam net except for the wings, wedges, and bellylines. The method of rigging the wing ends is illustrated in fig. 4. The wedges are rigged the same as in the Granton trawl (fig. 2), or, if the alternate wings are used, the wedges may be eliminated (fig. 4, (1) and (2)). The bellylines on this net are similar to those of the Granton trawl, for they too run only from the quarters to the selvedge. Selvedge lines are then required that run along the selvedge at the belly line down into the cod end. Standard methods of rigging the cod end are used.



Alternate Top Wing



Alternate Bottom Wing



These alternate wings will fit the above net maintaining the same headrope and footrope measurements.

Note: Leg and Bridle Arrangement

Suggested leg length 15 - 20 fathoms.
Top leg 1 foot longer than lower leg.

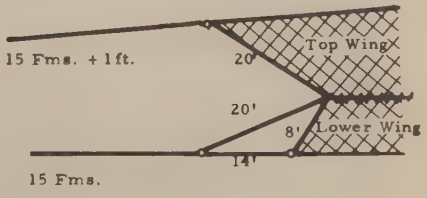


Figure 4.--Skagen or type "S" wing trawl.

Table 3.--Construction details for the Skagen or Type "S" wing trawl

Part	Specifications
Headrope	Three lengths 7/8" dia. comb. wire rope, 80' long: 32'; 16'; 32'.
Footrope	Seven lengths 7/8" dia. wire rope, 116' long: 14'; 20'; 15'; 18'; 15'; 20'; 14'.
Fishing lines	Five lengths 3/4" dia. comb. wire rope, 95' 6" long: 21' 6"; 16' 6"; 19' 6"; 16' 6"; 21' 6".
Wing end lines	Two lengths 3/4" dia. comb. wire rope, 40' long, marked 20' from eyes. Two lengths 5/8" dia. comb. wire rope, 8' long, with eye on each end.
Hanging line	1-1/2" cir. polypropylene rope.
Bellylines	Two lengths 3" cir. polypropylene rope, each 13' long with eyes.
Selvedge lines	Two lengths 3" cir. polypropylene rope; length equal to selvedge.
Quarter ropes	Two lengths 3" cir. polypropylene rope, 90' long.
Haul-up line	One length 2-3/4" cir. polypropylene rope, 110' long.
Roller gear	Roller gear to suit on footrope wires given. Rubber disks on wings stop at end of lower wing. Bare or rounded wire thereafter.
Floats	Suggested no. 36, 8" dia. aluminum floats: 18 on bosom, 9 each on wings.

ATLANTIC WESTERN TRAWL - MODEL III

The Atlantic Western trawl - model III (fig. 5) is one of a series of 4-seam or box trawls designed by W. W. Johnson of the Industrial Development Service, Department of Fisheries of Canada. Results of fishing experiments by the Canadians suggest that this net is an effective groundfish net, especially for use at night for species that then rise off the bottom. A headrope height of 20 feet claimed for the net was substantiated by tests made aboard the Bureau of Commercial Fisheries R,V. Delaware.

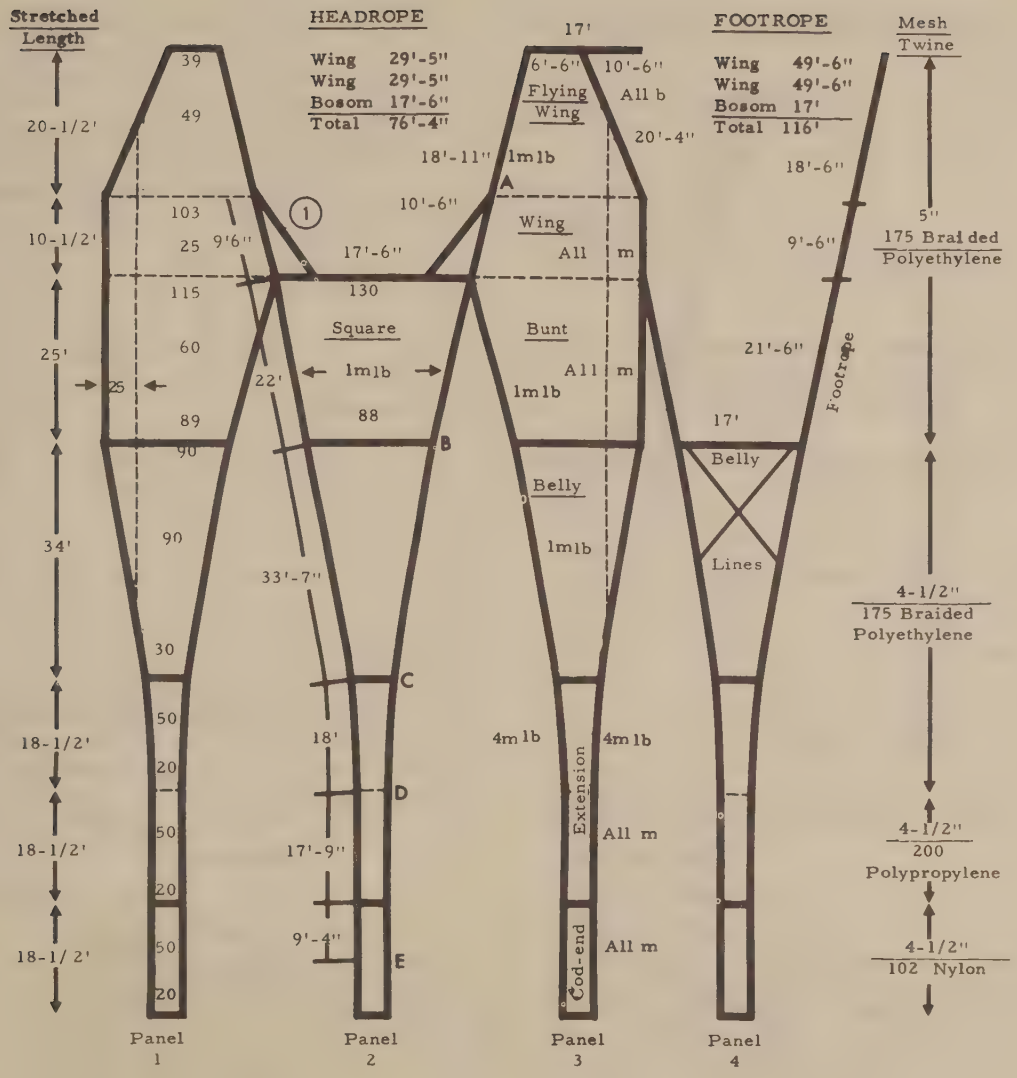
Compared to a 2-seam trawl, this 4-seam trawl embodies four major departures that are apparent at first glance: (1) top and lower wings are one piece of webbing; (2) the use of wedges and how they are attached to the wings are different; (3) four selvedges, hence four selvedge lines, or riblines, are used; and (4) the taper along the wings is not cut as dog-ears.

Any difficulty in making this net would probably arise from its departure from usual 2-seam net construction and not from its complexity.

Concern about extensive net damage and lost time at sea due to repairs to this type of net have not been supported by the actual experience of fishermen aboard Canadian or United States vessels. Damage when working rough bottom has, in most instances, been limited to the lower belly and those wing areas where there are no tapers. The belly is repaired in the same manner as the larger belly of the 2-seam trawl. The model III tested aboard the Delaware held its specified measurements under normal hard-bottom fishing, and this lack of change supports the belief that the balance of the net is stable.

The application of 4-seam trawls to groundfishing operations in the Northwest Atlantic is relatively recent, and changes are being made to these nets to facilitate fishing on rough bottoms. The model III described incorporates the latest changes currently available and is considered the best Atlantic Western net for fishing hard bottom.

Figure 5 shows the net laid out in four panels. Panels 1 and 3 show the side and wing panels. Panel 2 shows the top webbing. Panel 4 shows the bottom webbing. The figures to the left of Panel 1 are the webbing's stretched mesh measurements, which are familiar to most net builders. The mesh count for all sections of the net, except the wedges and square, are given in Panel 1. The wedge details are given in fig. 6B, and the width of the square is given in Panel 2. Along the left edge of Panel 2 are the ribline measurements from the wedge down to the cod end. These correspond to the selvedge or gore lines. On the right side of Panel 2 are the letters A through E which are placed alongside points on the ribline where adjustments can be made to realign the net when damaged and check measurements when building. Letter A designates the forward end of the wedge and square ribline. Panel 3 names the various sections and gives the tapers of all sections except the square which is found in Panel 2. Shown above Panel 3 is the length of the wing end rope and its hanging measurements. Panel 4 shows the bottom section, illustrates the bellylines and the breakdown of the footrope. The bellylines on this net function as strongbacks and not, as in a 2-seam trawl, to transfer the strain

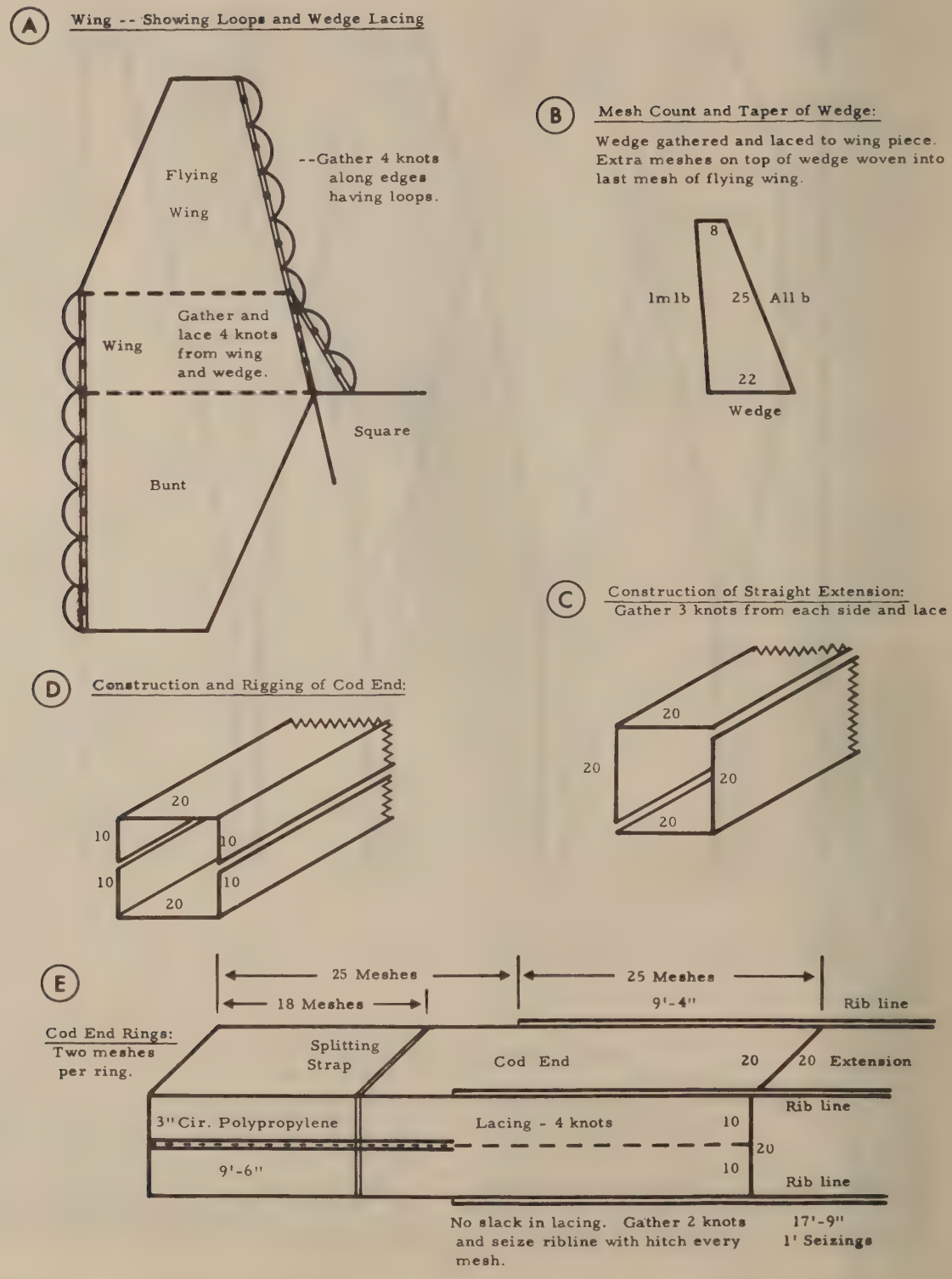


(1) Cutting of wedge on Figure No. 6B.

Figure 5.--Atlantic Western trawl - model III.

from the quarters to the selvedge. To the right of Panel 4 are the mesh sizes (stretched mesh) for each section along with twine fiber and size. A broken line 25 meshes up from the lower edges of the side panels is drawn on Panels 1 and 3. Major areas of damage are encountered below this line and will be mentioned later. The construction details are fairly standard as in other nets; this section does, however, give additional information for the assembly and rigging of this net.

Figures 6A, 6B, 6C, 6D, and 6E illustrate the shape of the wedge and other details which are departures from usual 2-seam net construction.



Figures 6A, 6B, 6C, 6D, and 6E.--Construction diagrams of the Atlantic Western trawl - model III.

Table 4.--Construction details for the Atlantic Western trawl - model III

Part	Specifications
Headrope	Three lengths 7/8" dia. comb. wire rope 76'-4" long: 18'-11" + 38'-6" + 18'-11". 38'-6" length marked 10'-6" from ends.
Footrope	Seven lengths 3/4" or 7/8" dia. 6 x 19 wire rope 116' long: 18'-6" + 9'-6" + 21'-6" + 17' + 21'-6" + 9'-6" + 18'-6".
Wing end rope	Two lengths 3" cir. nylon rope, 17' long.
Fishing line	One length 7/8" dia. comb. wire rope 18' long.
Hanging line	Five lengths 2-3/4" cir. polypropylene rope: 9'-9" + 22'-4" + 19' + 22'-4" + 9'-9". Two lengths 2-3/4" cir. polypropylene rope for flying wing taper - each 20'-4". Eye at each end.
Rib lines:	
Wings and squares	Two 34'-6" lengths of 2-1/4" cir. polypropylene rope, eye one end. Marked at successive intervals, 22' and 9'-6" from eye.
Belly to codend	Four 81'-8" lengths of 2-1/4" cir. polypropylene rope, no eyes. Marked at successive intervals, 3'; 33'-7"; 18'; 17'-9"; 9'-4" from one end.
Floats	Thirty-six 8" dia. aluminum floats.
Rollers	Roller gear and rubber disks to suit on footrope wires up to flying wing. Large diameter rollers (20") recommended.
Belly lines	Two lengths 1-1/2" cir. polypropylene rope 45' long.

The accompanying diagrams (figs. 5 and 6) provide most of the necessary information for building the Atlantic Western trawl - model III. There are five or six models of this net, although they are basically the same net of various sizes. Diagrams for a given model should be on hand if a type of Atlantic Western trawl, other than model III, is to be built. The following information is intended to supplement the accompanying diagrams rather than to be complete instructions in themselves.

Wings and Wedges

The wings of the Atlantic Western trawl are made up of three pieces of webbing--the flying wing, the wing, and the bunt (fig. 6A)--and serve as top and bottom wings. A wedge, cut as shown in fig. 6B, is attached to the wing piece as shown in fig. 6A by gathering four knots from each and lacing in the same manner as joining selvedges. The remaining meshes at the forward end of the wedge are secured to the meshes of the flying wing.

Loops or dog-ears are added to the top and lower edges of the wings, the bunt, and the wedge after four knots are gathered and laced along these edges. (This gathering of knots creates a strong area that is seldom torn out, allowing uncomplicated mending of damaged webbing in this area.) On the flying wing a loop of heavy or double twine is started with a hitch around the first group of knots at the wing end. The next hitch, which forms the loop, is made on the second group of knots down from the first hitch so that there will be one group of knots in the middle of the loop that does not have a hitch bent to it. The loop then is equal to 1 mesh in length (fig. 6A). This method of looping is continued along the flying wing and wedge down to the square.

On the lower edge of the wing and along the bunt, loops are made in the same manner. For accuracy in weaving the sections together, meshes at the bottom of the bunt and wedge should be left free for securing to belly and square and finished after these sections are woven together.

Lacing of the Net

The sections of this net are woven together with double twine down to the cod end. Assembly of the net can be started by lacing the selvedges along the top and side panels. The bunts and square are laced mesh for mesh, gathering four knots from each section. Continuing along these seams, mesh for mesh, the belly and tapered extension panels are gathered four knots and laced. The straight extension is assembled by folding each piece of twine lengthwise 20 meshes from an edge along a row of knots and gathering and lacing three knots from each side of the folded corners and three knots from each side of the selvedges (fig. 6C). Note that the bunt-square lacing aligns with the wedge-wing lacing. The bottom panel can be laced to the side panels in the same manner except that the starting point is the lower belly.

The cod-end pieces are laced together as shown in fig. 6D and the cod end woven into the extension, thus completing the webbing assembly.

Headrope and Hanging Lines

The headrope should be attached first as it assists in bending on the top riblines. The headrope is made up as specified in Table 4. Allowance for connecting links is made, and the headrope is marked at the quarters as indicated. The headrope is attached to the webbing in the usual manner--the connecting link being lined up with the flying wing double twine, and the quarter mark properly located where the square and wing meet.

A 2 3/4-inch circumference polypropylene hanging line is made up as per Table 4. The 20-foot 4-inch length is bent along the bars of the flying wing. The 9-foot 9-inch length is seized to the 20-foot 4-inch length and attached to the wing piece by the loops (dog-ears). The 22-foot 4-inch length of 2 3/4-inch polypropylene is seized to the 9-foot 9-inch length and secured to the bunt by the loops. The 19-foot bosom length is seized to the 22-foot 4-inch length and hung to the bosom meshes. Care should be taken with both headrope and hanging lines to make certain that the distribution of the webbing along these ropes is even.

Riblines

Wing-square riblines.--These riblines are made up of lengths of 2 1/4-inch circumference polypropylene rope and are marked as described in Table 4. They are hung to the selvedge with seizings 1 foot apart, starting with the eye at the top belly-square double twine, so that the 22-foot length is evenly spaced with the square selvedge and the 9-foot 6-inch length with the wedge selvedge. The 3-foot remainder is passed through the eye on the headrope, drawn up to align the 9-foot 6-inch mark with the headrope connecting link, and properly secured to the eye with a bend or hitch. The free end is seized back onto the ribline.

Belly-cod end riblines.--The top riblines, from the belly to the cod end, are two equal lengths of 2 1/4-inch circumference polypropylene rope, without eyes, marked as shown in fig. 5. The belly ribline is secured to the eye in the wing-square ribline at the 3-foot mark. The 33-foot 7-inch length is seized to the belly every foot, the 18-foot length to the tapered extension, the 17-foot 9-inch length to the straight extension, and the 9-foot 4-inch length to the cod end (stretch the cod end when bending on the ribline).

The two bottom riblines are secured to the bottom selvedges in the same manner as their top equivalents with the following exceptions: (a) the 3-foot mark is secured to the eye of the bunt hanging line, and (b) a 3-foot 9-inch length of ribline at the quarter is left free from the webbing to allow slack in the laceage in this area.

A 9-foot 4-inch length of 3-inch circumference polypropylene is seized every mesh along the side laceage of the cod end as shown in fig. 6E. As an alternative to this cod end arrangement, the 2 1/4-inch polypropylene riblines can be extended through the cod end.

Bellylines

The bellylines on this net differ from those of the usual 2-seam trawl in that they cross from the quarters to the opposite selvedge. They consist of two pieces of 1 1/2-inch circumference polypropylene rope about 45 feet long, which are secured to the eye of the bosom hanging line 5 meshes inward from the selvedge and are laced along the bar to the ribline on the opposite side. There they are secured to that ribline with 3 to 4 seizings for a length of 1 1/2 feet (fig. 5, Panel 4). Their main purpose, as previously stated, is to act as strongbacks to reduce damage and hold the shape of the trawl.

Wing End Ropes

The wing end rope is made up of 3-inch circumference nylon 17 feet long, with an eye on each end and marked 6 feet 6 inches from one end. The wing end webbing is hung across this 6-foot 6-inch length, and the forward end of the hanging line, which was previously bent to the wing, is secured at this mark. The lower leg is secured at the other (loose) end of the wing end rope. Shortening the lower end of the wing end rope by 1 or 2 feet and securing an equal length of chain to it and the lower leg reduce a lot of the chafing on this rope.

Floats

Thirty-six 8-inch diameter aluminum floats are normally used on this trawl when using 20-inch diameter rubber rollers. Eighteen are secured to the bosom, and 16 spaced evenly along the wings.

Roller Gear

Nets with roller gear need a fishing line 18 feet long at the bosom only. The remainder of the roller gear is secured directly to the hanging line with roller chains. The bosom roller wire (footrope) is 17 feet long, rigged with a standard roller arrangement. About 10 feet of rollers are used along the lower part of the wings, and rubber disks are attached along the remainder up to the flying wing. The 18-foot 6-inch length of wire footrope (see Table 4) is shackled to the disk end of the roller wire and to the junction of the 17-foot length of nylon wing end rope and lower leg. This wire has the eye splice located near the webbing covered or served to prevent tearing the webbing.

Legs and Ground Cable

The legs suggested for this net are 15 fathoms long; the top leg is 1 foot longer than the bottom leg. Ground cable lengths are used to suit the seabed conditions and preference of the captain.

Quarter Ropes and Beckets

The quarter ropes are 75 feet long and rigged in the usual manner. The beckets are attached on the headrope along the wedge to suit the vessel deck arrangements.

Splitting Strap and Codend Rope

The required splitting strap is attached 18 meshes up from the bottom of the cod end, held by a becket at each ribline with a 130-foot long haul-up line attached. The cod end rope is 21 feet long and is reeved through loops or rings, 2 meshes to the loop or ring.

Laceage on the Side Panels

The broken lines shown on Panels 1 and 3 of fig. 5 are 25 meshes up from the lower edges. Along this line four knots are gathered and securely laced with heavy or double twine. Fishermen have found that the greatest damage inflicted on this net occurs in the area between this laceage and the footrope hanging line. The laceage prevents the damage from moving up the side panels. Repair is made easier because a 25-mesh width of proper size netting can be made up to patch the damaged area. As there are few, if any, tapered edges involved, ease of patching results and the net balance is maintained. This method of limiting the damage is now common among a number of vessels using this net.

POLISH FACTORY SHIP'S TRAWL

Drawings and data on this trawl were obtained from the FAO (Food and Agriculture Organization) "Catalogue of Fishing Gear Designs." The metric weight and measurement system and the Tex system of twine size determination used in this catalogue were replaced with measuring systems in use among U.S. net builders. Mesh sizes given were not standard U.S. mesh sizes, so the nearest common mesh sizes were substituted. Where minimum mesh size regulations for cod and haddock fishing were not met, regulation size meshes were used. Certain rope sizes not used by U.S. fishermen were replaced with sizes to match U.S. practices. Every effort was made to reproduce the drawings and data in a form familiar to American fishermen while maintaining the measurements, materials, and proportions given in the FAO catalogue. The kite described in this catalogue is identical in description to one dragged up off the New England coast, presumably lost by a European vessel.

The Polish factory ship's trawl (fig. 7) is used aboard Polish factory stern trawlers about 275 feet long, powered by 2,400-hp. engines. Trawls similar to the net described here have been seen aboard large Polish stern trawlers that have put into United States ports.

Four to six years ago, European fishermen changed the basic Granton trawl design (fig. 2) to increase its headrope height and reduce damage to the net when fishing over rough bottom. The results of these changes are most notable in the wings, and this style net became known as the "Modified Granton" or "French Granton" trawl. In adapting this trawl to use aboard their large stern trawlers, the Polish have kept the basic shape of this net, adding features for stern ramp use and changing mesh and twine sizes whenever they felt it was effective.

The heavy strongbacks leading aft from both top and bottom quarters (A-B-C-D-E-F in fig. 7) strengthen the net and make it more manageable when hauling aboard a large catch. In addition to headrope floats, 24 to 32 floats are strung along the top strongback to the cod end to add lift and decrease chafing. The selvedge lines are in the standard Modified Granton practice of starting from the wing ends and following the laceage down to the cod end. Both the strongbacks and the selvedge lines are 20 percent longer than the stretched mesh length of the sections to which they are secured.

Other departures from large New England trawl net practices observed in this Polish trawl are: (1) smaller twine size and larger mesh size in the wings, square, and first belly sections; (2) a pinched effect at the juncture of the belly and tapered extension due to a reduction in mesh size; (3) a long tapered extension; and (4) double twine in both extension and cod end.

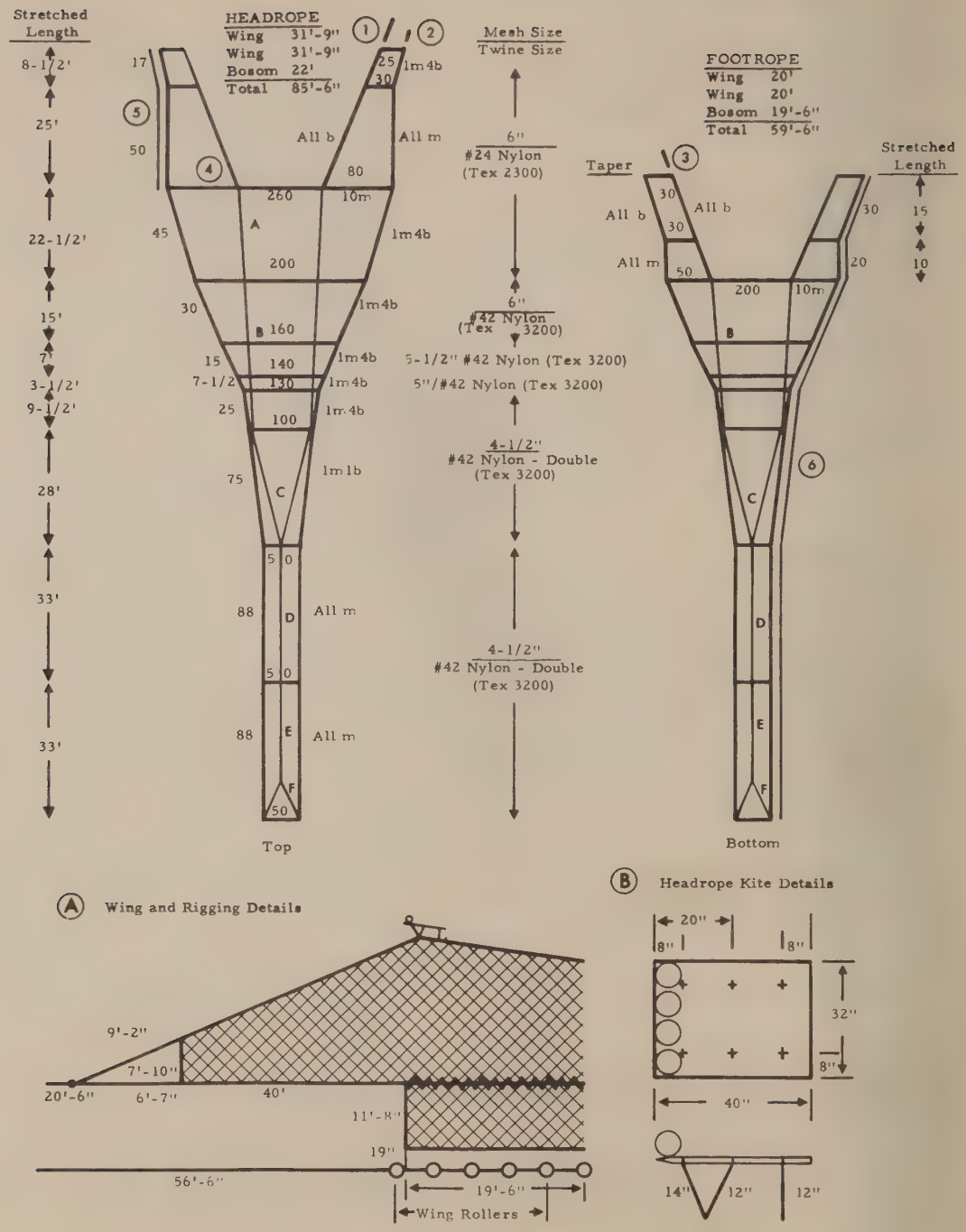


Figure 7.--Polish factory ship's trawl.

Table 5.--Construction details for the Polish Factory Ship's trawl

Part	Specifications
Headrope	Three lengths 7/8" dia. comb. wire rope: 31'-9"; 22'; 31'-9". Total 85'-6".
Footrope	Three lengths 7/8" dia. comb. wire rope: 20'; 19'-6"; 20'. Total 59'-6".
Wing end ropes	Two lengths 5/8" dia. comb. wire rope per wing. Top wing 7'. Bottom wing 11'-8".
Hanging lines	Top - one length 1 1/2" cir. polypropylene rope, marked 41'; 36'; 41'. Total 118 feet. Bottom - one 1 1/2-inch cir. polypropylene rope, marked 24'-6"; 31'-6"; 24'-6". Total 80'-6".
Strongbacks from bosoms to cod end	(All strongbacks 1" dia. comb. wire rope.) From quarter to cod end: A - 27'; B - 30'; C - 45'; D - 39'-6"; E - 27'-6". Letter F to end of cod end - 12' each fork.
Floats	Along headrope - 34 to 42, 8" dia. aluminum floats. Along cod end - 24 to 32, 8" dia. aluminum floats.
Kites	Center of headrope - one kite as shown in detail B, fig. 7. Material: Wood, 32"x40"x1". Floats: Four 8" dia. aluminum floats. Straps: 5/8" dia. comb. wire rope, lengths shown in figure 7.
Rollers	21' dia. iron rollers, weight 209 lbs. each, iron spacers between. Five rollers in bosom. Five rollers on each wing (1 roller forward of webbing). One roller at each quarter. Total 17 rollers.
Roller wire	Three lengths 1" dia. 6 x 19 wire, each 19'-6" long. Total 58'-6".
Roller chains	5/16" or 3/8" dia. chain 19" long. Spaced to suit.
Legs	Top legs - 13/16" dia. 6 x 19 wire, 20'-6" long. Lower legs - 1 1/16" dia. 6 x 19 wire, 56'-6" long. Standard danleno with spreader used.
Notations on Fig. 7:	
(1)	End straps secured to top leg - 1/2" dia. 6 x 19 wire, 9'-2" long, eye each end. (See detail A, fig. 7.)
(2)	13/16" dia. 6 x 19 wire, 6'-7" long, eye each end. (See detail A, fig. 7.)
(3)	End strap secured to lower leg - 1/2" dia. 6 x 19 wire, 1'-7" long. (See detail A, fig. 7.)
(4)	Double twine for 10 meshes at corner.
(5) and (6)	Selvedge lines: top wing - two 40' lengths, 1 1/2" cir. polypropylene rope; bottom wings and laceage - 1" dia. comb. wire rope; lower wing - 30'; belly - 30'; tapered extension - 45'; straight extension - 39'-6"; cod end - 39'-6".

NUMBER 36 TRAWL

The trawl net most commonly found on the medium-size groundfish draggers in New England is the Number 36 trawl (fig. 8). This net, smaller than the Number 41 trawl generally used by the large trawlers, is common on vessels from 75 feet to 90 feet long and powered by 200- to 350-hp. engines. It is towed over both very hard and smooth grounds off New England in pursuit of cod, haddock, hake, pollock, redfish, and various flounders, and also is fished in waters off New York and New Jersey for fluke, scup, and tilefish. It is not the most efficient net for flatfish but is used occasionally, without rollers, for this purpose.

The net that is illustrated represents the typical Number 36 trawl. The basic net data of 15 years ago have been changed to conform to minimum mesh size for haddock and cod fishing. For other uses the mesh sizes could be changed, but this would require changing the mesh count to retain the shape of the trawl. Attention is directed to the 10-foot wide lower bosom; the current trend in modifications to this trawl is to increase this bosom length.

The Number 36 trawl has otherwise been variously modified to suit the requirements of the skipper and fishing conditions. If a random group of Number 36 nets now being used was measured, few of them would likely be found to have the same dimensions. Differences between these nets would be found in the webbing and gear arrangement; the particular choice of rollers, bosom lengths, wing lengths, float arrangements, and extensions would diverge widely. The net resulting from extensive modification is often called a "Mongrel 36" among fishermen, and has given rise to what may be called a "subspecies" of trawl net, the "60-80" trawl.

Table 6.--Constructions details of the Number 36 trawl

Part	Specifications
Headrope	One piece 3/4" to 7/8" dia. comb. wire rope, 60' long, marked 23' from each end. Eye on each end.
Footrope	Five pieces 11/16" to 3/4" dia. 6 x 19 wire, 80' long: 17'-6"; 17'-6"; 10'-0"; 17'-6"; 17'-6". (Allow for connecting links.)
Wing end rope	One piece 3/4" dia. comb. wire rope 5' long.
Hanging line	Optional on top wings. Nets using rollers only have one piece 3" to 3 1/4" cir. polypropylene rope, 85' long, secured to lower wings and bosom, which is seized in bights to wing footrope and by roller chains to roller gear.
Floats	Thirty two 8" aluminum floats, 18 on bosom, 7 each on wings.
Roller gear	Three units for bosom and wings - use footrope wires.
Bosom	Five 16" or 18" wooden rollers, spacers as needed.
Wings	Five 16" or 18" wooden rollers, 3 spacers between at quarters trailing up wing with spacers. End 17'-6" footrope - rubber disks along length.

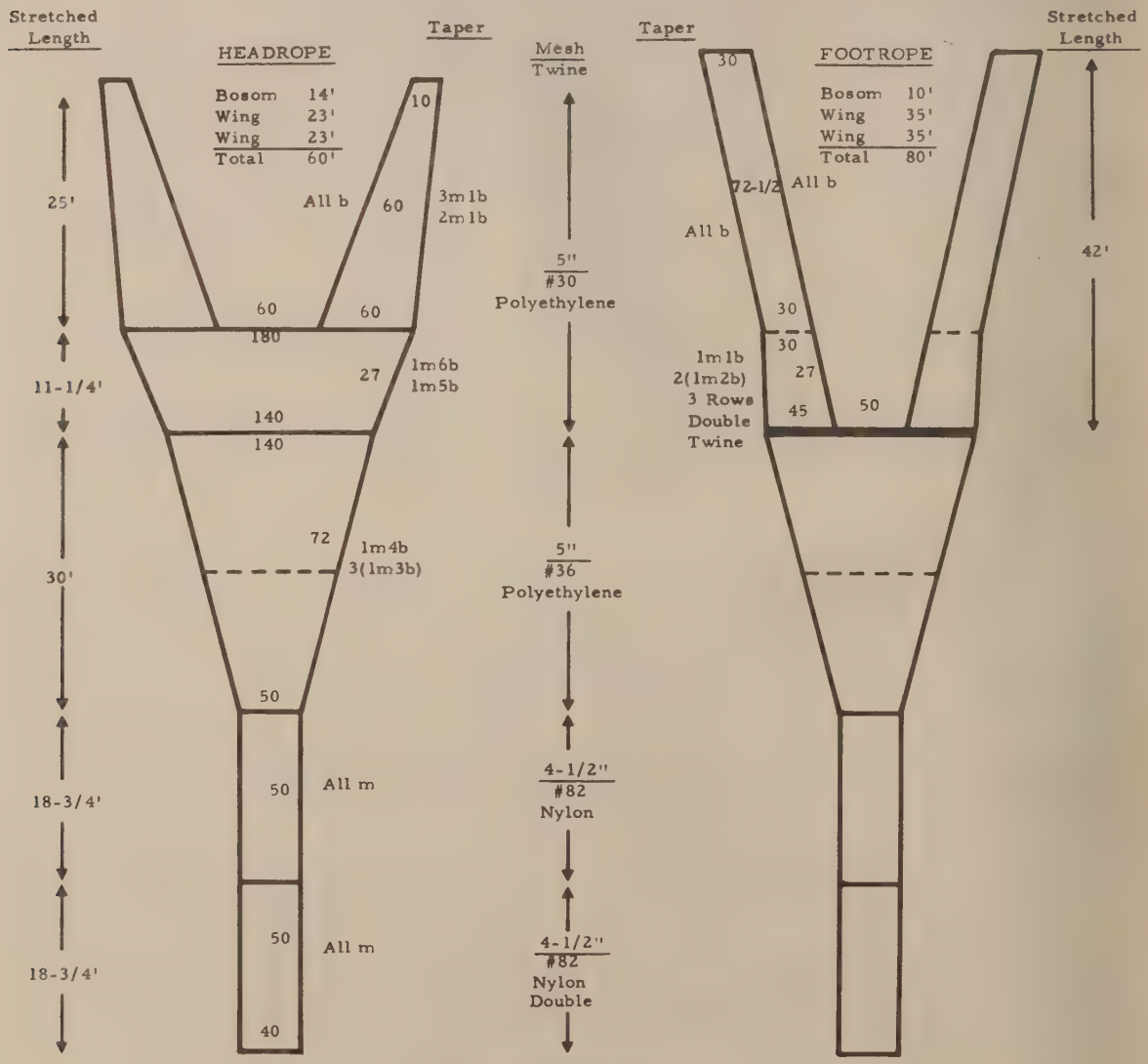


Figure 8.--Number 36 trawl.

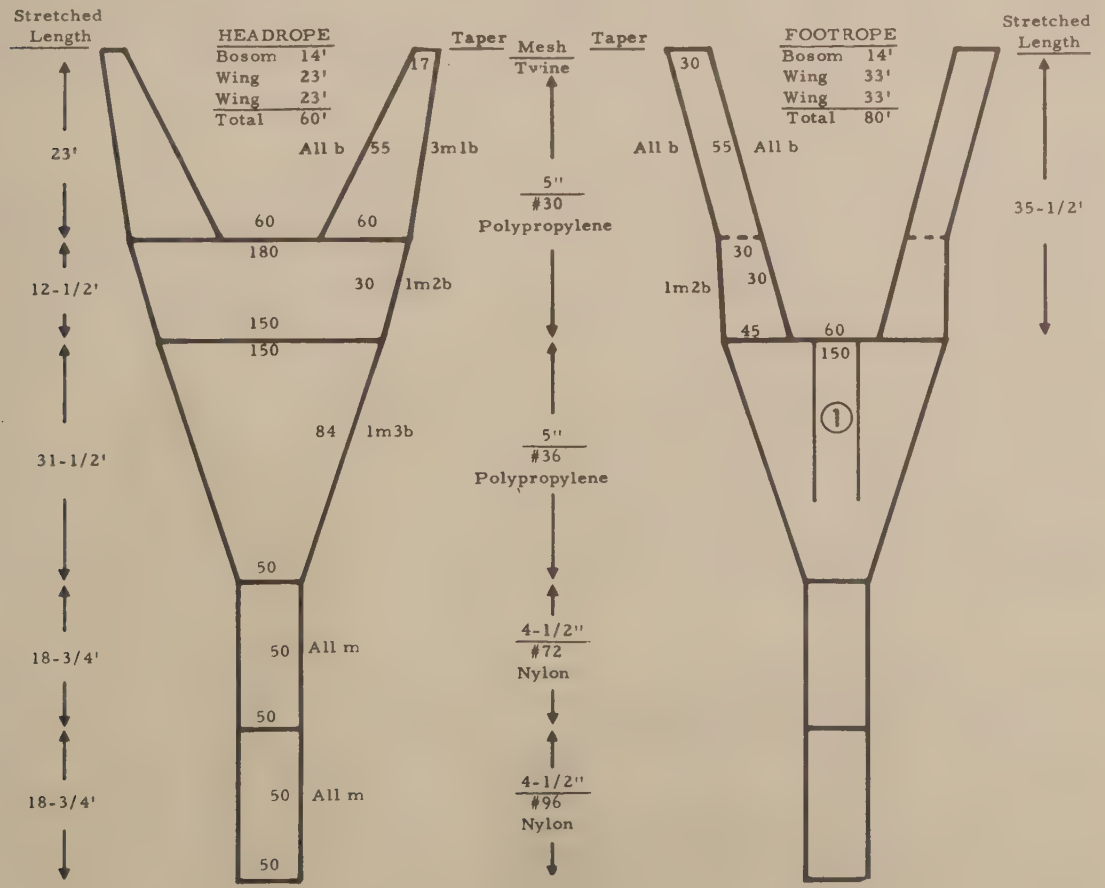
"60-80" TRAWL

Medium-size trawlers use numerous trawl nets that are identified by the lengths of their headrope and footrope. One of these nets is the "60-80" trawl--the headrope being 60 feet long and the footrope 80 feet long. This net may be constructed from Number 36 trawl net sections.

The net illustrated (fig. 9) is made of nylon twine of smaller diameter than usually found on nets of this size, and this use reflects the growing interest among fishermen in synthetic fiber twines that have greater strength than cotton or manila. Other synthetic twines that do not absorb water and thus tend to float, such as polypropylene and polyethylene, are used also. The smaller and lighter twine permits easier passage of the net through the water with resultant lowered "towing resistance."

The success of a net with the 60-80 headrope/footrope arrangement has encouraged many fishermen to use this ratio and has stimulated them to experiment with other parts of the net. If the vessel does not have the power to tow a full-sized "60-80," this net can be altered by changing sections and shortening the headrope and footrope but retaining the same length ratio. The resulting net would then be known to its owner by the lengths of its headrope and footrope. Such altered nets are commonly known as "mongrel nets."

The present tendency is to lengthen the bosom footrope of nets in the 60-80 size. Bosom footrope sections vary between 12 feet and 18 feet--14 feet is a common length. This lengthening is accomplished by hanging the lower belly meshes farther apart or by using a 150-mesh belly as shown in figure 9 rather than the standard Number 36 belly



① Strongbacks running down the lower belly are often used to minimize damage.

Figure 9.--"60-80" trawl.

of 140 meshes. The larger belly may be more than 72 meshes deep.

The extension shown in figure 9 does not represent an actual extension. Rather, it is an illustration of how the body length of the net can be adjusted to accommodate the type of fishing in which the net is used. Again, the designer considers the requirements of the vessel and type of fishing. The adaptability of Number 36 net sections in this net eliminates the need to design and cut special sections for the entire net.

Table 7.--Construction details of the "60-80" trawl

Part	Specifications
Headrope	One piece 3/4" or 7/8" dia. wire rope, 60' long, marked 23' from each end.
Footrope	Five pieces 11/16" or 3/4" dia. 6 x 19" wire, 80' long. 16'; 17'; 14'; 17'; 16'.
Wing end rope	Two lengths 3/4" dia. comb. wire rope, 6' & 15'.
Hanging line	Nets using rollers only - one piece 3" or 3 1/4" cir. synthetic rope 86' long, marked 35' from each end.
Floats	Thirty to thirty six 8" floats, 18 on bosom, and remainder along wings.
Roller gear	Three units for bosom and wings. Roller wire 11/16" dia.
Bosom	Six or seven 16" to 18" dia. wooden rollers. Spacers as needed.
Wings	Five or six 16" to 18" dia. wooden rollers. Three spacers between rollers at quarters, trailing to spacers or rubber disks. 16" wing rope, wire covered with rubber disks.

The "60-80" trawl net is likely to have a simple construction to facilitate overhaul and repairs. For example, one net may have three rows of double twine at the lower bosom and a lower belly of heavy strong twine (No. 60 or larger). Another net of the same general dimensions and the same 60-80 headrope/footrope ratio may have no double twine at the bosom and a relatively light (No. 30 or No. 36) lower belly with strongbacks as shown in figure 9. Both these alterations in the construction of the lower belly are made for the same reason: The net is to be used on rough bottom. The builder of the first net had ruggedness in mind; the second, ease of repair. Thus the "60-80" might be termed a "Skipper's Net," adapted to the characteristics of a particular vessel and modified to suit the preference of the captain.

WHITING TRAWL

The whiting trawl (fig. 10) is a net developed for the small- and medium-sized New England trawlers, which fish generally for silver hake (whiting).

There has been little standardization in the whiting trawl because whiting vessels have a great range in size and power. The captains of most vessels have their own concepts of what sizes and shapes their whiting nets should be. Footrope lengths may vary from 70 feet for a low-powered 50-foot vessel to 110 feet or more for the high-powered 85- to 100-foot vessels.

Netting materials in these trawls were cotton until the introduction and acceptance of synthetic fibers: first, nylon and, recently, polyethylene. Use of synthetic fiber has led to a longer-lasting trawl which weighs less both in and out of the water and requires fewer floats. With these new fibers smaller vessels are able to handle larger trawls.

The whiting trawl usually has an uncomplicated design and construction. As many of these trawls are constructed by the vessel's crew under direction of the captain, they are relatively simple so that little time is lost in their making. Tapers are few and can be remembered easily. Some whiting trawls have the same taper from the wing ends to the extension, thus simplifying the mending and patching on the dock and at sea.

The whiting trawl shown in figure 10 illustrates a basic departure from most 2-seam otter trawls: The lower belly is wider than the top belly. The effect of this modification is that the net has a wide lower bosom to fish over the smooth seabeds where whiting usually are caught. The wide lower belly and light synthetic webbing in the net allow small- and medium-sized vessels to handle a trawl with headrope and footrope lengths equal to those used by large Boston-based beam trawlers that fish primarily for haddock and cod over hard-bottom areas.

Table 8.--Construction details of the whiting trawl

Part	Specifications
Headrope	One length 3" cir. polypropylene rope, 82' long, marked 30' from each end.
Footrope	One length 3" cir. polypropylene rope, 104' long, marked 41' from each end.
Wing end ropes	Two 5' lengths 2 1/4" cir. polypropylene rope.
Quarter ropes	72' lengths 3" cir. polypropylene rope.
Haul up line	100' length 2 3/4" cir. polypropylene rope.
Splitting strap	Strap 15' around made up of 3" cir. polypropylene rope, secured 6' from end of codend.
Codend rope	16' length 2 3/4" cir. 4-strand twisted or loose braided rope.
Floats	Seven 8" dia. aluminum floats, three on bosom and two on each wing.
Chain	156' - 1/4" dia. fish net chain hung 18 links to the foot along the footrope. Weight about 120 lbs. Additional chain may be hung along the bosom and ends of wings if needed.

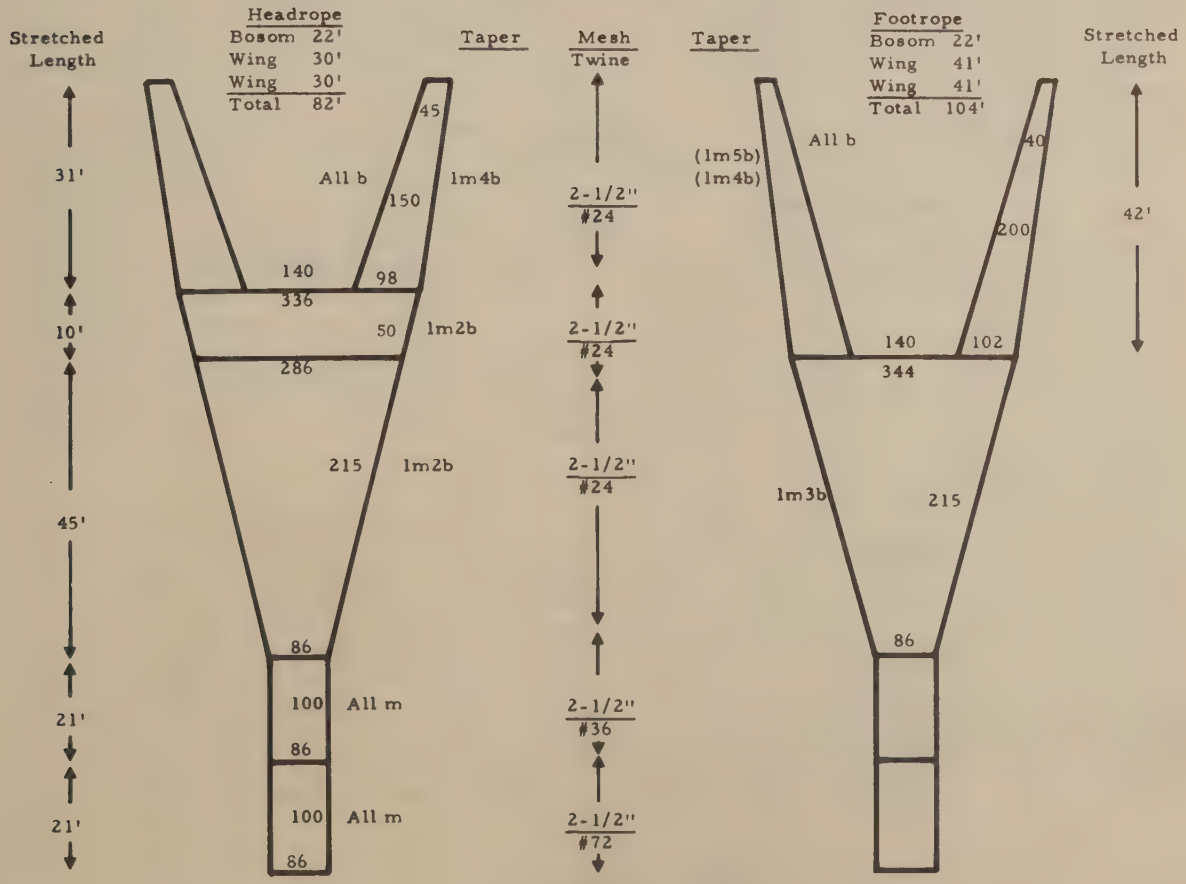


Figure 10.--Whiting trawl.

FLOUNDER TRAWL

The flounder trawl is a type of net used in New England waters to capture flatfish on muddy or sandy bottoms (fig. 11). Called a "flat net" by the fishermen, it is in general use among vessels from 50 to 75 feet long that fish for various species of flounders. This type net is also used for catching industrial fish species, such as red hake, eelpout, skate, and searobin, found near the bottom.

The flounder trawl and the whiting trawl (fig. 10) are somewhat similar. The flounder trawl shown has a taper of 1 mesh/2 bars from wing end to extension on the top sections, and 1 mesh/3 bars from wing end to extension on the bottom sections. This taper results in the lower belly being wider than the top belly. Often the square and the top belly are cut from the same piece of netting so there is no discernible separation between them. Vessels using this net seldom have ready-cut sections aboard but rely on patching to handle major repairs. A slightly different taper is used on the whiting trawl (fig. 10), but the square and belly are cut from the same piece of webbing with no separation, and the lower belly is wider than the top belly. The overall sizes and rigging of both nets are similar.

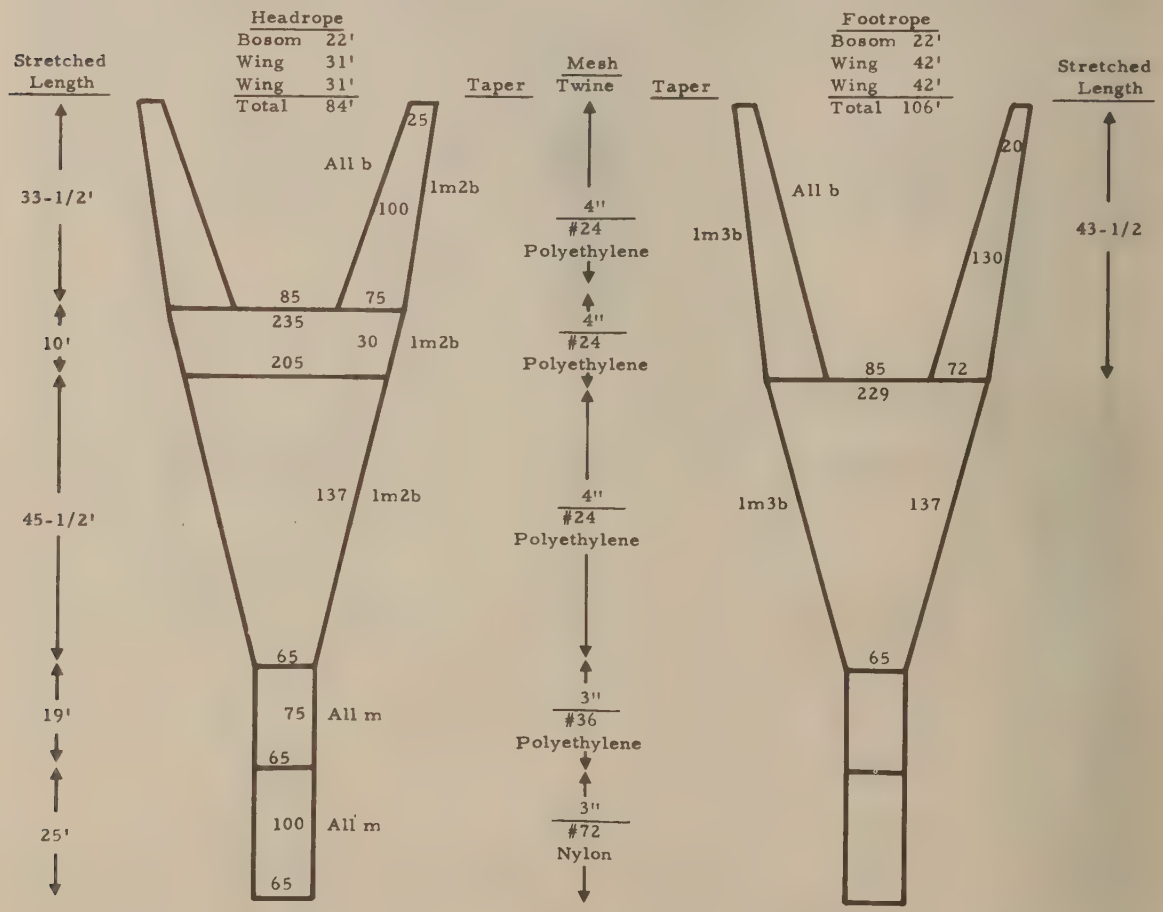


Figure 11.--Flounder trawl.

Table 9.--Construction details of the flounder trawl

Part	Specifications
Headrope	One length 3" cir. polydacron rope, 84' long, marked 31' from each end.
Footrope	One length 3" cir. polydacron rope, 106' long, marked 42' from each end.
Wing end ropes	Two lengths 2 1/4" cir. polydacron rope, each 6' long.
Quarter ropes	80' lengths 3" cir. polydacron rope.
Haul-up line	115' length 2 3/4" polydacron rope.
Splitting strap	Strap 15' around, made up from 3" cir. polydacron rope, secure 7' from end of codend.
Codend rope	16' length of 2 3/4" cir. 4-strand twisted or loose braided rope.
Floats	Twelve 8" dia. aluminum floats: 4 on bosom, the remainder evenly spaced on wings.
Chain	160' of 1/4" dia. fish net chain hung 18 links to the foot along the footrope. 12' additional chain hung along wing from each wing end, and 35' of 3/16" dia. chain hung along bosom. Weight about 130 lbs.

Some fishermen put a tickler chain on this net when using it for flounders or industrial fish that live close to the bottom. A tickler chain is a chain somewhat shorter than the footrope and is secured to the trawl so that it sweeps the seabed just in front of the footrope and stirs up the fish in front of the net. Shrimp vessels in the Gulf of Mexico also use such devices for shrimp.

This trawl is another example of a large headrope/footrope net which, because of small twine size and light synthetic fibers, can be handled by medium-size vessels of moderate power.

60-FOOT SHRIMP TRAWL

The three most common shrimp trawls used in the Gulf of Maine fishery are the 50-, 60-, 70-foot trawls, which are named according to the length of their footrope. One type of these trawls is a modification of a style of trawl used in the Gulf of Mexico shrimp fishery. The size of vessels that catch shrimp in the Gulf of Maine ranges from 35 feet to 65 feet, and these vessels use a size of trawl proportionate to their length and horsepower.

The net illustrated (fig. 12) is a 60-foot shrimp trawl used on vessels of about 45 feet in length and powered by 150- to 200-hp. engines.

The net illustrated uses 2-inch stretched mesh throughout, but this is not a firm mesh size. Some nets may be constructed using 2 1/8-inch mesh. The cod end depicted in figure 12 is a representative cod end and could be less than 110 meshes around. Mesh sizes down to 1 1/2 inches are used on some vessels. An extension may also be added to this net.

Experience with this style shrimp trawl has impressed the fishermen with the need for accuracy when assembling the trawl. An effort is made during assembly and repairing to ensure that gathering, sewing, and lacing are undertaken in a "mesh for mesh" manner when joining sections. Headrope and footrope measurements are frequently checked. To preserve balance, the top and bottom wedges are sewn, not laced, to the wing sections.

The shrimp fishing season in the Gulf of Maine area is usually from December through March; many fishermen continue using these shrimp trawls for whiting in the late spring and summer.

Table 10.--Construction details of the 60-foot shrimp trawl

Part	Specifications
Headrope	One length 2 1/4" cir. polydacron rope, 48 1/4' long, marked 12 1/2' and 7 1/2' from each end.
Footrope	One length 2 1/4" cir. polydacron rope 60 1/2' long: marked 12 1/2', 6', and 7' from each end.
Wing end ropes	Two 5' lengths 2" cir. polydacron rope.
Chain	90' - 1/4" dia. fishnet chain secured in equal lengths along the footrope. Weight about 60 lbs. Adjust to suit.
Floats	Four 8" dia. aluminum floats. One secured at each corner of the bosom and at each end of the top wedge. Adjust number to suit.
Selvedge lines	1 1/2" cir. polydacron rope of a length equal to stretched mesh length of laceage.
Quarter ropes	Two lengths 2 1/4" cir. polydacron ropes, 52' long.
Haul-up lines	One length 2 1/4" cir. polydacron rope, 41' long.
Splitting strap	One strap 2 1/4" cir. polydacron rope, 14' around, hung 6' from codend.
Codend rope	One length 2" cir. 4-strand rope, 14' long.

Note: During assembly of this net, particular attention should be given during the lacing together of the sections to make sure that the gathering and lacing be done on a mesh-for-mesh basis, so that the webbing is matched evenly. The wedges may be sewn into the lower wing sections rather than laced to these wings.

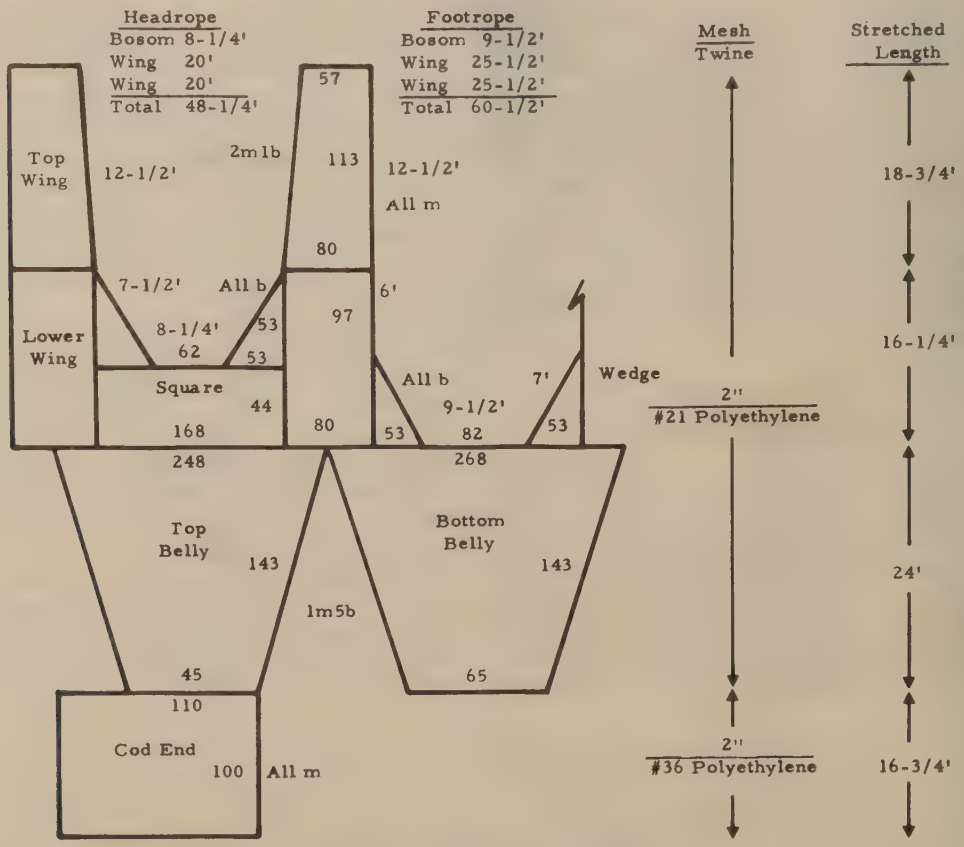


Figure 12.--60-Foot shrimp trawl.

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REFERENCES

BINNS, H. N.
1959. Trawling gear. In Hilmar Kristjonsson (editor) Modern fishing gear of the world, p. 297-299. Fishing News (Books) Ltd., London.

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS.
1965. Catalogue of fishing gear designs. Fishing Gear Section, FAO Fisheries Division, Food and Agriculture Organization of the United Nations, Rome, Italy. FAO Data Sheet No. 107, FAO Plan Nos. 107-A and 107-B, 24 p.

GARNER, JOHN
1962. How to make and set nets. Fishing News (Books) Ltd., London, 95 p.

GARNER, JOHN, and ALAN GLANVILLE.
1961. Deep sea trawling and wing trawling. Gourock Ropework Co., Ltd., Port Glasgow, Scotland, 106 p.

KNAKE, BORIS O.
1956. Assembly methods for otter-trawl nets. U.S. Fish Wildl. Serv., Fish. Leafl. 437, 29 p.

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